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Extensive Heifer Development Systems

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INTRODUCTION

Studies in numerous species provide evidence that diet during development can partially control physiological changes necessary for puberty (Frisch, 1984). Energy balance or plane of nutrition influences reproductive performance in heifers and cows (Butler and Smith, 1989; Randel, 1990; Robinson, 1990; Short and Adams, 1988; Swanson, 1989). Numerous studies have reported inverse correlations between postweaning growth rate and age at puberty (Arije and Wiltbank, 1971; Ferrell, 1982; Short and Bellows, 1971; Wiltbank et al., 1966, 1969, 1985) and pregnancy rates in heifers were shown to be dependent upon the number displaying estrus prior to or early in the breeding season (Byerley et al., 1987; Short and Bellows, 1971). Thus, rate of postweaning growth was determined to be an important factor affecting age of puberty, which influenced pregnancy rates. This and other research conducted during the late 1960s through the early 1980s indicated puberty occurs at a genetically predetermined size, and only when heifers reach their target weight can high pregnancy rates be obtained (reviewed by Patterson et al., 1992). Guidelines were established indicating replacement heifers should achieve 60 to 65% of their expected mature body weight by breeding. Traditional approaches for postweaning development of replacement heifers used during the last several decades have primarily focused on feeding heifers to achieve or exceed an appropriate target weight, and thereby maximize heifer pregnancy rates. Substantial changes in cattle genetics and the economy have occurred over this time, indicating traditional approaches should be re-evaluated. Intensive heifer development systems may maximize pregnancy rates, but not necessarily optimize profit or sustainability. These systems require significant use of fossil fuels and cereal grains, and high capital investment in equipment and facilities. Cereal grains, often used as an energy source in heifer diets, detract from the system's sustainability due to growing demand for human food and ethanol production. Furthermore, almost all studies on heifer development conducted over the last half century have focused on production to first calving with little information concerning effects of heifer development systems on lifetime productivity.

Since inception of target weight guidelines, subsequent research demonstrated the pattern of growth heifers experience prior to achieving a critical target weight could be varied. Altering rate and timing of gain can result in periods of compensatory growth and/or allow producers to limit supplementation to critical periods of heifer development thereby providing an opportunity to decrease feed costs (Clanton et al., 1983; Freetly et al., 2001; Lynch et al., 1997). For example, delaying heifer gain until 47 or 56 d prior to the breeding season did not negatively influence reproductive performance, but reduced the amount of feed needed (Lynch et al., 1997). In one year of this study, puberty was delayed in heifers fed to achieve

lower early gains, but first-service conception rate tended to be improved in these same heifers. Similarly, Freetly et al. (2001) found delaying gain until the later part of the postweaning period reduced total energy intake, but calving rate, age at calving, postpartum interval, and second year pregnancy rate were not impacted. These studies indicate that total energy intake, and possibly heifer development costs, may be reduced by limiting heifer gain early in the postweaning period followed by accelerated gains before the breeding season.

REVIEW OF TARGET WEIGHT

As indicated previously, substantial research contributed to the guidelines of developing heifers to 60 to 65% of mature body weight at time of breeding. Studies evaluating different postweaning rates of gain or target weights have used either different amounts of feed, or different types of feeds varying in energy and/or protein content to obtain differences in rates of growth. A review of these studies conducted over the last several decades along with new research discussed later, indicates the association among BW, puberty and heifer pregnancy rate appear to have changed over time. Research reports published through the late 1980s have shown much greater negative effects of limited postweaning growth on age of puberty and subsequent pregnancy (Patterson et al., 1989; Short and Bellow, 1971; Wiltbank et al., 1985), where as more recent studies indicate less of a negative impact of delayed puberty on pregnancy response (Buskirk et al., 1995; Freetly and Cundiff, 1997; Lynch et al., 1997). Several factors likely contribute to this change over time. Initial research corresponds to the industry shift from calving heifers at 3 years of age to calving at 2 years of age. Thus, selection pressure for age of puberty was probably minimal in animals in the early studies. While selection intensity would have increased with the reduction in calving age of heifers, genetic progress would take time due to the long generation interval in cattle. In 1978, researchers identified the association between scrotal circumference in bulls and age of puberty in their daughters (Brinks et al., 1978). Since then, scrotal circumference has been used as an indicator trait for puberty. Breed association web sites show substantial increases in scrotal circumference occurring from 1985 to the present, indicating great progress has been made through selection for this trait; a similar response in age of puberty would be expected. Indeed, the inability of heifers to attain puberty prior to breeding may not be as problematic as heifers reaching puberty before weaning (Gasser et al., 2006a and 2006b).

The association between timing of puberty and subsequent pregnancy rate also seems to have changed over time. Early research indicated heifers should experience two or three estrous cycles before the onset of the breeding season because fertility of the first estrus is lower than subsequent estrous cycles (Byerley et al., 1987). Thus delayed onset of puberty was expected to be associated with lower pregnancy rates. However, several studies have not shown strong associations between nutritionally related changes in age of puberty and final pregnancy rates (Buskirk et al., 1995; Ferrell, 1982; Freetly and Cundiff, 1997; Lynch et al., 1997). Evidence for a genetic basis for these differences is provided by Freetly and Cundiff (1997), who reported pregnancy rates were greater in heifers AI sired by bulls born after 1988 than bulls born between 1982 and 1984, but age and weight at puberty were not. These changes, combined with the continued increase in cost of harvested feedstuffs indicate the need for alternative development systems which allow heifers the opportunity to conceive early as yearlings at reduced cost.

CURRENT RESEARCH

Feeding replacement heifers to traditional target weights increased development costs relative to more extensive heifer development systems where heifers were developed to lower target weights ranging from 51 to 57% (Funston and Deutscher, 2004; Larson et al., 2009; Martin et al., 2007; Roberts et al., 2007 and 2009b). Feeding to pre-breeding weights as low as 51% of mature weight was shown to be more cost effective than development to 57% of mature weight, even though lighter heifers were allowed a 15 d longer (45 vs. 60 d) breeding season (Martin et al., 2007). Extending the breeding season by 15 d for lighter heifers resulted in similar conception rates between systems, but pregnancy rates for the first 45 days of the breeding season, were 89.8 and 77.9% for heifers fed to 57% or 51 % of mature weight, respectively. Further characterization of non-pregnant heifers within each system revealed 78.9% of open heifers developed to 51 % of mature weight but only 45% of open heifers developed to 57% of mature weight were pre-pubertal prior to start of the breeding season. This lends support to the hypothesis that one of the major determinants to a heifer's ability to conceive during her first breeding season is the age she reaches puberty, especially in relation to the start of the breeding season. Heifers calving early during their first calving season have greater lifetime calf production than those calving late and are more likely to become pregnant sooner at two years of age (Lesmeister et al., 1973). However, there was no difference in second-calf conception rates between cows developed to 51 or 57% of mature weight prior to breeding as yearlings (Martin et al., 2007). This indicates lighter heifers that became pregnant during the 15 d extension during the first breeding season rebred with similar efficiency as those pregnant within the initial 45 days. Therefore, proportion of heifers retained as pregnant 2-yr olds was similar between systems. Thus, heifers may be developed to lighter than traditional target weights without negative effects on profitability or future productivity.

Research at Fort Keogh evaluating lifetime productivity of heifers developed with either unlimited or restricted (27% less feed) feed during the postweaning period supports the potential to reduce target weights and costs during heifer development (Roberts et al., 2007 and 2009b). The association of age at onset of breeding and cumulative pregnancy rate was similar for heifers developed on the two protocols. However, restricted heifers were lighter at a given cumulative pregnancy rate. Thus, age at the beginning of the breeding season was more critical than body weight. Furthermore, rate of growth from birth to weaning accounted for more variation in puberty and AI pregnancy rate than did ADG during the postweaning period. Neither age nor ADG prior to postweaning period influenced final pregnancy rate. Thus, age and early growth rate (up to ~ 8 mo. of age) influenced time of puberty and conception, but did not alter overall pregnancy rate in a 48 to 60 d breeding season.

When summarized over the last 7 years, heifer pregnancy rate was 3.5% less in heifers developed under restricted feeding at Fort Keogh. Restricted feeding during the 140-d postweaning period reduced harvested feed inputs by 22% and increased efficiency of gain. After restriction, restricted heifers remained lighter but had greater ADG. Restricted feeding improved biological and economical efficiency during and after the feeding period.

Pregnant heifers resulting from the two postweaning treatments were also fed at different levels throughout each subsequent winter. Heifers developed without restriction were provided adequate levels of harvested feed from early December through calving while heifers developed on restricted feeding were fed 20 to 45% less harvested feed. Restriction resulted in lower bodyweights throughout 5 yr of age (Roberts et al., 2009a) which may equate to lower maintenance requirements.

Heifer offspring from the two management groups were randomly assigned to restricted or non-restricted protocols resulting in 4 treatments: restricted cows from restricted dams, restricted cows from control dams, control cows from restricted dams and control cows from control dams. Interestingly, cows from restricted dams were 35 to 50 lbs heavier than cows from non-restricted dams at 3 to 5 yr of age, due in part to differences in BCS (Roberts et al., 2009a). Thus, method of developing and maintaining replacement heifers may influence offspring growth and development. Differences in weight and BCS may also impact longevity. Current data indicate that retention to the 5th breeding season was influenced by dam and cow treatments. Retention was lowest for restricted cows from non-restricted dams (39%), intermediate for non-restricted cows from either restricted (50%) or non-restricted (51%) dams, and greatest for restricted cows from restricted dams (66%). Preliminary evaluation of the performance of the third generation of calves found that calves from restricted cows out of restricted dams were lighter at birth and weaning by 3 and 13 lbs, respectively. Thus, restricted cows from restricted dams may have a lower level of production and greater fleshing ability resulting in greater retention. Current data indicate that the small decrease in calf output may be more than compensated by increased longevity.

It is expected that cows from non-restricted dams would be most similar to conditions evaluated in previous research, where level of dam nutrition has not generally been considered, but likely managed for optimal production. In this respect, comparison of non-restricted cows from non-restricted dams to restricted cows from non-restricted dams fits the expected results from previous research concerning negative effects of nutritional restriction on reproduction. The negative effects continued to cumulate over the 5 breeding seasons. A novel observation is the apparent influence of the dam's level of nutrition on its offspring's response to nutritional treatment. While number of cows with observations for retention to 5 breeding seasons is limited, the data indicate that managing cows on marginal levels of nutrition, improved the ability of their offspring to sustain reproductive performance when they were managed with marginal levels of harvested feed inputs.

Several similarities exist between the heifer development studies conducted at the University of Nebraska (Funston and Deutscher, 2004) and Fort Keogh. Both locations used similar types of cattle (composites with ~½ Red Angus and ½ continental breeding) and the treatments resulted in development to similar target weights at breeding (53 vs. 58 and 55 vs. 58 % of expected mature weight). Growth rates during the development period were similar between locations for the two treatments imposed and both locations observed approximately a 10% reduction in proportion of heifers pubertal at breeding in the lower input groups. Magnitude of savings achieved by lower target weights was also similar (~22-24$/pregnant heifer). In contrast to the Nebraska research, a slight decrease in pregnancy rate (3-5%) has been observed in heifers under restricted feeding at Fort Keogh (Roberts et al., 2009b).

Methods used for restricting rate of development differed between Nebraska (lower quality diet) and Fort Keogh (lower quantity fed) which may contribute to differences in pregnancy. These studies indicate an opportunity to improve efficiency and decrease production costs by decreasing amount and/or quality of harvested feeds used for heifer development.

SUMMARY

Postweaning management of heifers to achieve traditional target weights, particularly by feeding high-energy diets, is not supported by current research. Heifers developed on forage, however, generally require additional protein supplementation to achieve even modest gains. One reason reproductive performance has not been drastically impaired by feeding to lower target weights may relate to genetic changes in age of puberty.

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